Moving motivation

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Chapter 6

Prompting in an Internet-based physical activity intervention: A randomized control trial in adults aged 50+

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Abstract

Background: A lack of sufficient physical activity (PA) is an important public health problem. Internet intervention programs are a potential solution, but small effect sizes and adherence problems demonstrate a need for further improvement.

Objective: To examine the effect of an Internet-based PA intervention for adults aged 50 and over while studying prompting as a strategy to increase adherence.

Methods: An Internet-based randomized controlled trial (RCT) compared the effects of a six-week Internet-based intervention that aimed to enhance physical activity (PA) levels with and without prompting emails. Participants (N = 190) self-enrolled on the intervention website, and 30 were excluded from the analysis as they did not match the target group criteria. Measurements were taken before, during, and after the intervention. The sample whose data were analyzed comprised 160 participants at baseline and 121 at post-measurement. The main outcomes were motivation and three PA assessments. Multilevel regression was used to analyze change over time until the post-measurement. The explanatory variables were group allocation, time, and baseline characteristics. General linear modeling for repeated measures was used to assess change after the post-measurement at one- and six-month follow-ups.

Results: The intervention was not effective in increasing motivation or PA over time. Prompts did not increase adherence, as there was no difference in intended program use between the prompting and non-prompting groups.

Conclusion: Not enough is known about the effective components of an Internet-based program for adults over the age of 50.

There is substantial evidence that physical activity (PA) is necessary to maintain physical and mental health, but a vast number of adults of all ages do not meet the recommended thirty minutes of exercise per day (World Health Organization [WHO], 2010). To stimulate people to increase their level of PA, many PA behavior interventions have been initiated (Chase, 2015; Conn, Hafdahl, & Mehr, 2011; Conn, Valentine, & Cooper, 2002), with various degrees of success. Over the last decade, the use of the Internet for health interventions has become more common. The results of Internet interventions for physical activity are promising but need further investigation (Aalbers, Baars, & Olde Rikkert, 2011; Davies, Spence, Vandelanotte, Caperchione, & Mummery, 2012). Small effect sizes of Internet-delivered PA interventions and problems with participant adherence show a need for further improvement (Davies et al., 2012; Kelders, Kok, Ossebaard, Van Gemert-Pijnen, 2012; Kohl, Crutzen, & de Vries, 2013). A review showed that a higher intensity of interventions and more use of dialogue support predicted better adherence (Kelders et al., 2012).

The aim of the current study is to examine the effect of an Internet-based PA intervention for adults aged 50 and over while studying prompting as a strategy to increase adherence in a randomized control trial. For this purpose, a six-week Internet-based program was designed. It included an Internet-based PA plan, diary and tips in addition to paper-based information in the form of two PA brochures. Email prompts were sent to half of the participants (assigned at random) to study the effect of the prompts on program adherence and effectiveness. We used knowledge available from the *Active Plus* project (van Stralen, Kok, de Vries, Mudde, Bolman, & Lechner, 2008) on useful intervention goals and specific change objectives for physical activity in older adults.

The intervention was developed using a theory-based two-phase approach to behavior change (Sniehotta, Scholz, & Schwarzer, 2005). The use of theory in intervention design is important for a proper foundation of intervention programs and may result in more effective interventions (Chase, 2015; Webb, Joseph, Yardley, & Michie, 2010). In the intentional phase, a person makes the decision to change his or her behavior based on his or her beliefs. In the action phase, also called the volitional phase, specific plans are made and actions are taken to change behavior. The two phases translate into two types of intervention components, i.e., targeting beliefs and intention and targeting action, which both need to be addressed in an intervention to stimulate participants to go from intention to behavior (Sheeran, 2002). PA interventions for older adults using both types of components were found to be more effective than interventions using either type of component (Chase, 2015; King 2001).

The action phase is supplemented with a prompting technique to enhance adherence to the intervention, which is defined as "the extent to which individuals experience the content of an intervention" (Kelders, Kok, Ossebaard, Van Gemert-Pijnen, 2012, p. 2). To target adherence, we used prompting as an intervention strategy. Prompts are defined as "messages, reminders, or brief feedback communicated to participants multiple times over the duration of an intervention" (Fry & Neff, 2009, p. 2). In daily life, other goals often conflict with the goal of being more physically active (Abraham & Sheeran, 2003), which distracts people from their plan to become more physically active. Reminding users of the target behavior is supposed to help them achieve their PA goal (Oinas-Kukkonen & Harjumaa, 2009) by keeping it salient over time (Abraham & Sheeran, 2003). A review on adherence to Internet-based health interventions (Kelders et al., 2012) found that prompts in the form of reminders are used frequently (74% out of 83 interventions), and the use of dialogue support that included reminders significantly predicted adherence. Two reviews showed that the use of prompts in health behavior interventions is effective on short-term measures of behavior; however, comparative experimental studies on prompts are rare, and more knowledge about how prompts work is needed to apply them effectively (De Leon, Fuentes & Cohen, 2014; Fry & Neff, 2009). The use of prompts is especially interesting with the increased use of electronic devices such as personal computers in behavioral interventions because of the potential to reach participants during their daily life (De Leon, Fuentes, & Cohen, 2014).

The present research aims to examine the effect of prompting in an Internet-based physical activity intervention. The research questions are as follows: does an Internet-based intervention for adults over 50 using behavioral change techniques that target both the intentional phase and the action phase of behavior change work? Does prompting help increase participant engagement in the Internet-based intervention? Hypothesis 1 is that the intervention is effective in increasing motivation and PA. Hypothesis 2 is that prompting increases adherence to the intervention, which in turn (Hypothesis 3) increases physical activity.

Methods

Study design and procedure

A two-group randomized control trial was conducted with measurements before (pre-measurement), during, and after the intervention (post-measurement at six weeks and follow-up at one and six months) to assess its effectiveness. To assess the effectiveness of email prompts, participants were randomized and equally allocated

to a group that received the Internet-based intervention including email prompts (i.e., prompting group) and a group without email prompts (regular intervention). Measurements included registration of PA by means of an accelerometer, weekly questionnaires and an Internet-based PA diary. Questionnaires were conducted online using questionnaire software (Qualtrics). Participants were invited to answer questions by clicking on a hyperlink, which was provided on the intervention website or by email.

Potential participants were informed on the intervention website about the details of the intervention study. The online registration procedure included creating an online account (name, email and password), completing an online informed consent form and completing a short registration questionnaire on participants' background characteristics and preferred starting date for the intervention program. Approximately two weeks before the start of the study, participants were requested to fill out a pre-measurement questionnaire. The number of accelerometers was limited to approximately 100; therefore, the actual starting date of the program was determined based on the availability of both the participants and accelerometers.

An overview of the timing of the intervention and study activities is given in Table 1. In the week before the start of the intervention, participants received a package at their home address through postal mail. It contained an accelerometer as well as a letter with instructions on how to use it and what was expected of them during the first week (i.e., wearing an accelerometer during waking hours and registering physical activity through an Internet-based PA diary). During the first week of the six-week program, no active intervention content was delivered; this was done to establish a baseline measurement. During the second week, participants received an information package containing an explanation of the intervention, two brochures, and an explanation and example of the Internet-based PA plan. Participants were encouraged to fill out the Internet-based PA plan in the second week. Every Saturday, participants received an email with the request to fill out a questionnaire.

Prompting emails were sent to half of the participants. These emails were paired with PA tips in order to motivate participants to go to the intervention website. For the prompting group, the presentation of the PA tips on the intervention website was timed so that a new PA tip was available when a prompting email was sent. The non-prompting group could access all PA tips on the intervention website in week 2. This setup was used to make sure any difference between the groups would be related to the prompts and the related timing of available information and not to differences in the information available.

Table 1. Overview of intervention and study activities

Registration	Pre-measurement	Wk 0	Wk 1 Baseline	Wk 2	Wk 3-6	End of wk 6	1 month	6 months
Creating account								
Informed consent								
Registration questionnaire (A)	Pre-measurement questionnaire (B)		Weekly questionnaires (C)			Post-measurement questionnaire (D)	Follow-up question-naire (E)	Follow- up question-naire (F)
		Accelerometer sent by mail	Accelerometer worn by participants			Request to return accelerometer		
			Internet-based PA diary					
		General information about wk 1 sent by mail		General information about wks 2-6 sent by mail Two brochures sent by mail Internet-based PA planning tool				
				Non-prompting group: Internet-based PA tips				
					Prompting group: three emails/ PA tips a week			

Questionnaire A: Revised Physical Activity Readiness Questionnaire (rPARQ), demographics, preference for starting date of the intervention. B to F: Physical Activity Scale for the Elderly (PASE), motivation to change, physical activity self-regulation (PASR-12). B, D and F: knowledge of PA. B, D, E and F: stage of change, 11 item De Jong Gierveld loneliness scale, health (SF-12). D: use of intervention program. E: extra information about PA (also part of evaluation). E and F: use of intervention in past weeks.

After six weeks, at the end of the study, participants returned the accelerometer by mail and filled out the post-measurement questionnaire. The intervention study was conducted during a period of six months with twelve starting dates. Between one and 37 participants started the program on each date. Two follow-up questionnaires were distributed after one and six months of the intervention using an email link. Reminders were sent to those who had not filled out the questionnaire.

Intervention

The content of the intervention consisted of an Internet-based PA plan and diary, Internet-based PA tips and two full colour informational brochures about physical activity of which one targeted at older adults (Unie KBO & NISB Consult, 2012) and one at adults in general (Dutch Heart Foundation, 2012) that were sent by postal mail to the home address of the participants. The prompting group received prompting e-mails in addition to this. The Internet-based intervention content was delivered in steps (Table 1) during the intervention period through a personal, password-protected intervention website.

The *PA plan* was an Internet-based scheduling tool aimed to create a personal plan for several weeks. The plan consisted of three parts: (1) goal setting in which goals are chosen and a time frame within which to achieve them; (2) choosing specific activities, both sports and daily activities; (3) planning in a weekly schedule when, where and how to do each activity. The *PA diary* was a weekly schedule in which participants register the amount of minutes per activity that they performed for each day of the week. The website automatically presented a total amount of minutes, for each activity, and for the total day and week. The diary was presented for the current week and past diaries could be accessed in an overview. Feedback on the amount of activity is given in the form of a traffic light color (red, orange or green) around the number of minutes, signaling if the total amount of activity reached the norms. The *PA tips* consisted of twelve animated videos, approximately one minute long, created with the web based program goanimate.com. A male and female animation character each presented equal numbers of PA tips. Content of the videos was additionally shown as regular text (not subtitles), because during the pilot phase some people indicated that the voices of the characters were hard to hear. PA tips were categorized into four overall themes, each containing three tips. Content of the PA tips was the same for both intervention groups, but for ease of use they were combined for the non-prompting group into four tips with approximately three minute long videos. *Email prompts* consisted of a personalized heading and a brief message informing participants of a new PA tip on the intervention website. E-mail prompts were automatically sent by the website to the prompting group from the third week until

the sixth week on Monday, Wednesday and Friday. *Brochures* contained information about physical activity and health such as PA norms, advantages of PA and personal stories in order to increase motivation to become more active. More information about the intervention can be found in Chapter 3.

Calculation of sample size needed

For the calculation of the necessary number of participants, an effect size of .50 was applied based on the results of a previous study with comparable design and study sample (Prestwich, Perugini, & Hurling, 2010). With a power of .80 and an alpha level of .05, at least 64 participants per group are needed. Taking into account 30% attrition, which is an estimate on the safe side as 20% to 23% attrition is found on average in internet trials (Davies et al., 2012), we needed a total sample size of 183 participants. Sample size was calculated in Gpower3 (Faul, Erdfelde, Buchner, & Lang, 2009).

Randomization

Randomization followed upon completion of the baseline measurement. A randomization sequence with zeros and ones in blocks of twenty was created using the web based program researchrandomiser.com. The resulting sequence was programmed into the intervention website. Group allocation followed automatically once a starting date for the intervention was allocated to a participant by the researcher at the backend of the intervention website. Allocation to intervention group was double blind to prevent researcher bias. However, the researcher conducting the study could check allocation in a participant overview screen in case a participant would ask specific questions relating to group specific content. During the study, the researcher did not use this information.

Inclusion of participants in the study

The intervention study was carried out between September 2013 and March 2014 and six month follow-up data was collected up to September 2014. The target group consisted of people aged over 50 living in the Netherlands with a need and a wish to be more physically active. Participants were recruited by means of a press release, an Internet-based advertisement on health related websites and email newsletters. Inclusion criteria for participants were: age over 50 and not sharing the household with another study participant. In addition, participants had to be able to check their email regularly during the intervention. The revised physical activity readiness questionnaire (rPARQ) was used to evaluate whether participants were physically able to increase PA. If participants answered yes to any of the questions of the rPARQ they were asked to evaluate if participating would be safe for them and first contact their physician if necessary (Cardinal, Esters, & Cardinal, 1996).

On the intervention website 213 people registered their email address. The flow chart in Figure 1 illustrates participation to the study over time. Thirteen people did not start the registration questionnaire, five did not finish the registration and four did not finish pre-measurement, one person resigned from participation after filling out the pre-measurement questionnaire. Thirty-eight percent of participants (n = 72) answered yes once or more on the rPARQ questionnaires and decided that increasing physical activity was safe for them; they did not exclude themselves from the study. The most common confirmative answer on the rPARQ was taking some type of medication against high blood pressure (n = 50).

A total of 190 participants were randomized into the intervention group with email prompts (n = 98) and the group without email prompts (n = 92). Mean age of participants is 62.2, the majority is female (n = 138, 73%), and three quarter is highly educated (n = 144, 76%).

Exclusion of participants from analyses

The program unexpectedly also attracted very active people which are not considered to be the target group. Based on a Latent Class Analysis (LCA) with indicators *motivation*, *stage of change* and *physical activity* at baseline we identified thirty participants who were already very active for a relatively long time with low intention to change, compared to 160 participants who were less active and scored relatively high on intention to change; see Table 2). We excluded the very active group from further analyses as they fell outside the target group. The LCA was conducted with Mplus version 5.0. The lowest Bayesian information criterion (BIC) was used to determine the amount of classes along with the Vuong-Lo-Mendell-Rubin Likelihood ratio test for K versus K-1 classes and an entropy measure (.917) which indicated high precision of assignment to the latent classes (Muthén & Muthén, 2000; Nylund, Asparouhov, & Muthén, 2007). The exclusion of the active participants was indifferent to group allocation to prompting. A post hoc power calculation showed a difference between groups with an effect size of .25 or higher can be detected with this sample.

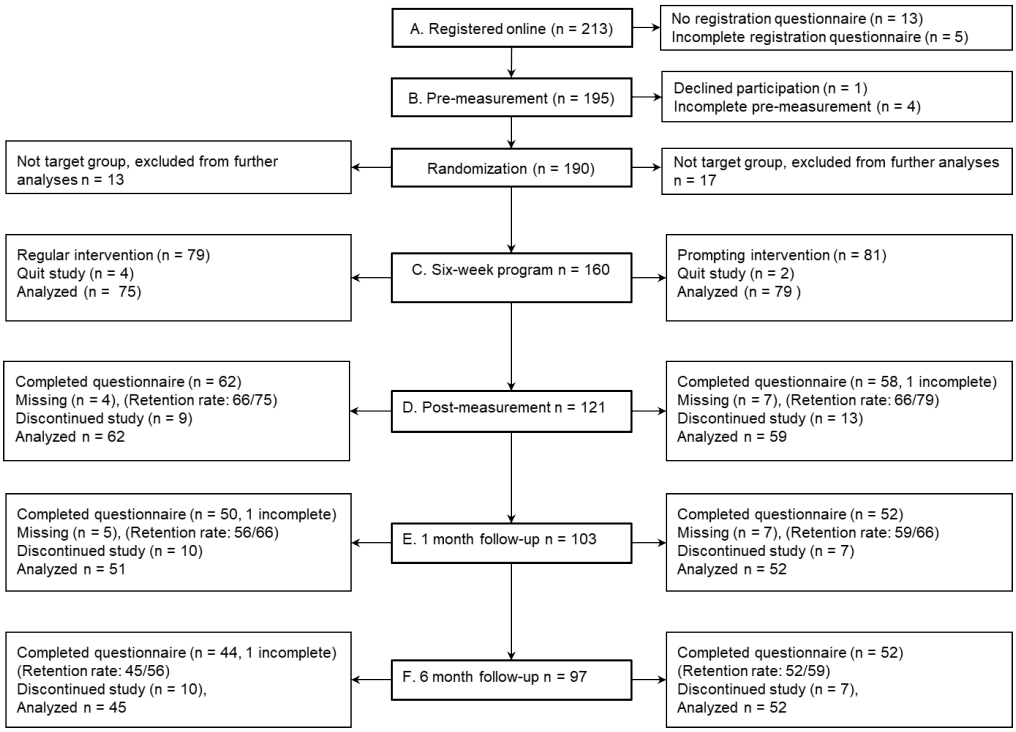

Figure 1. Flow chart of participation to the intervention study

Measurements

PA and motivation

Physical activity was assessed with an accelerometer, a questionnaire and an Internet-based PA calendar. For the accelerometer measurements we used a hip worn uni-axial accelerometer. The device used was the PAM, model AM200 (58x42x13 mm) which registers movement of the body every minute (Slootmaker, Paw, Schuit, van Mechelen, & Koppes, 2007). The output is a daily score of total minutes of physical activity in three Metabolic Equivalents of Task (MET) intensity categories (1.8-3, 3-7, >7) and was used to calculate weekly totals of all three intensities and of moderate and heavy intensity.

The physical activity scale for the elderly (PASE) is a self-report measurement indicating the overall amount of physical activity during the past week (Harada, Chiu, King, & Stewart 2001; Washburn, Smith, Jette, & Janney, 1993). It includes sports as well as recreational activities, household work and physical activity during (volunteer) work. The validity of the PASE was found to be sufficient in a Dutch sample (Schuit,

Schouten, Westerterp, & Saris, 1997). Total scores are calculated taking into account time spent in different activities and using item weights that are derived empirically (Washburn, Mcauley, Katula, Mihalko, & Boileau, 1999; Washburn, Smith, Jette, & Janney, 1993).

In the Internet-based physical activity calendar specific activities were registered during the six weeks of the program. Time in minutes was registered in the following categories; riding a bike, walking, gardening/house repairs, housekeeping, sports, swimming and other. If the 'other' category was used, the specific activity could be filled out, and a box could be ticked for each day the activity was performed. Totals for each day and each activity were automatically calculated and visible for the participant. For the analyses we used the daily average per week, i.e. total time in minutes per week spent on all reported activities divided by the amount of days reported in that week with a minimum of three days.

Motivation for physical activity is measured by the sum of three items (pre-measurement $\alpha = 0.91$), two related to effort and one to intention, measured on seven-point Likert scales. The items to measure effort were 'I am motivated to be more physically active than usual the coming week/weeks' and 'I will exert effort to be more active than usual the coming week/weeks' (Rhodes, Blanchard, Matheson, & Coble, 2006). The item for measuring intention was 'I have the intention to be more physically active than usual in the coming week/weeks' and is related to the Theory of Planned Behaviour (Ajzen, 2002).

Adherence

Intended usage is a type of adherence measure as explained by Kelders et al. (2012, p. 2): "Intended usage is the extent to which individuals *should* experience the content (of the intervention) to derive maximum benefit from the intervention, as defined or implied by its creators." Intended use in the present study was defined as; read minimally one of the two brochures, fill out the PA plan, use the diary for at least three weeks and view at least half of the PA tips. Intervention use is measured objectively by the website software for the Internet-based diary, plan and PA tips and subjectively for the brochures. Use of the brochures was measured by a question with three answer categories 'not seen', 'seen but not read', and 'seen and read'.

Demographics, health, loneliness, stage of change

As part of the registration questionnaire, participants' gender, date of birth, educational level, body height and body weight were assessed. Educational level was assessed in categories that are relevant for the Dutch educational system and

categorized into low and high educational level. Age and BMI (kg/m^2) were calculated. General health was measured at pre- and post-measurement using the SF-12 (Ware, Kosinski, & Keller, 1996), which has a mental and physical health subscale. Loneliness was measured at baseline with the 11 item De Jong Gierveld loneliness scale (De Jong Gierveld & Kamphuis, 1985). Stage of change was assessed at pre-measurement with one question adapted from Marcus et al. (1992). The question assesses which of five stages described the physical activity stage the best 1.'I am currently not regularly physically active and do not intend to change this', 2. 'I am currently not regularly physically active and consider to change that' 3. 'I am already physically active but not sufficiently and want to do more' 4. 'I am currently regularly physically active and started being active in the last six months' 5. 'I am currently regularly physically active and have been doing so for more than six months'.

Statistical analyses

General descriptive statistics are presented in Table 2, comparing discrete variables with the *Chi*-square test (Fisher's exact tests when appropriate) and comparing continuous variables using Student's *t*-test. Missing values on independent measures (one for age and one for educational level) were replaced by the mean. Drop out analysis was performed using logistic regression at post-measurement and one month and six months follow-up with group allocation, gender, educational level, age, BMI and baseline measures intention, physical activity, stage of change, loneliness, physical and mental health as predictors.

Multilevel regression (linear mixed modelling in SPSS) was used to analyze change over time up to the post-measurement in three assessments of PA and one of motivation; two to six (for calendar and accelerometer) or seven (for motivation and PASE questionnaire) observations were nested in participants. Explanatory variables were group allocation, a linear and quadratic term for time, and the invariant or baseline characteristics age, gender, educational level, BMI, mental and physical health. Whether change in PA differed between the two intervention groups was studied by including interaction terms for group and the two time variables. All continuous explanatory variables were grand mean centered and categorical variables were coded into dummy variables in order to facilitate interpretation and prevent collinearity in the quadratic term for time. Participants with at least two observations were selected for analysis. Participants with an incomplete set of activity measurements were only excluded in the analysis of that specific PA assessment, contributing both to the power of the analyses and, by minimizing selection bias, to the validity of results (Schafer & Graham, 2002). First a null-model was estimated describing change in all participants with a constant (intercept). Then in steps, the parameters for group (to

assess whether there was a difference across all observations), time, and time squared (to assess change over time across all participants) were added. The interaction terms of time and group were added to test the hypothesis that group allocation has an effect on the outcome variables over time. In a next step age, gender and BMI were added, and finally the two health variables and educational level were added.

We also tested whether there was change after the six-week period of intervention, i.e., in the interval between post-intervention and the one-month follow-up, and in the interval between post-intervention and the six-month follow-up. Multilevel analysis was not applied for these time intervals due to missing data. We applied general linear modeling for repeated measures in SPSS to compare motivation and PA as measured by the PASE on these two intervals.

Ethics

The study protocol gained approval from the research committee of the faculty of Social Sciences, Vrije Universiteit. The study protocol was also reviewed by the VUmc Medical ethical committee and received exemption from full ethics approval.

Results

Baseline characteristics and drop out

There were no differences between the intervention groups at baseline in background characteristics, health, physical activity and intention to change, which indicates that the randomization was successful (Table 2). Missing values at post-measurement and six months follow-up were not related to characteristics at baseline ($N = 160$; $Chi^2_{(12)} = 20.0$, $p = .07$; and $Chi^2_{(12)} = 15.7$, $p = .20$, respectively). At one month follow-up missing values were related to stage of change, physical and mental health at baseline ($N = 160$; $Chi^2_{(12)} = 22.4$, $p = .03$). Participants who were 'already physically active but not sufficiently and want(ed) to do more' were more likely to have a one month follow-up measurement ($B = 1.0$, SE = .4, 95% CI Exp B [1.2, 6.4]). Participants with higher scores at baseline for physical health ($B = 0.1$, SE = 0.03, 95% CI Exp B [1.0, 1.1]) and mental health ($B = 0.1$, SE = 0.02, 95% CI Exp B [1.0, 1.1]), were more likely to have a measurement at one month follow-up.

Table 2. Baseline characteristics of participants: Mean (SD) or proportion

	Excluded based on LCA (N = 30)		Total group for analysis (N = 160)		Difference between latent classes (p)	Non-prompting group (n = 79)		Prompting group (n = 81)		Difference between intervention groups (*p*)
Female (%)	57		76		.03	77		74		64
Age (years)	64.5	(6.7)	61.7	(7.4)	.05	61.9	(8.3)	61.6	(6.5)	.80
High education	.80		74.4		.51	.79		.70		.24
BMI	24.0	(3.6)	26.6	(4.0)	.001	26.0	(3.2)	27.1	(4.7)	.09
Physical health	50.7	(7.5)	49.3	(7.5)	.35	49.7	(6.9)	48.9	(8.2)	.52
Mental health	54.1	(5.4)	51.1	(9.1)	.08	50.7	(9.0)	51.4	(9.2)	.65
Loneliness	3.0	(3.0)	2.8	(3.1)	.66	2.7	(3.0)	2.8	(3.3)	.87
PASE	179.1	(101.3)	123.7	(66.5)	.01	117.2	(60.5)	130.1	(71.8)	.22
Motivation	2.5	(1.1)	5.8	(1.0)	.00	5.7	(1.0)	5.8	(1.0)	.43
Stage of change					.00					.52
2	.10		.29			.25		.33		
3	.00		.56			.59		.52		
4/5	.90		.15			.15		.15		

Notes. LCA stands for latent class analysis. Educational level was dichotomized into high and low. BMI = body mass index (kg/m^2). Range of scores; SF-12 subscale for physical (23.8 - 61.4) and subscale for mental health (18.9 – 63.7), loneliness (0-11), PASE (Physical Activity Scale for the Elderly; 0 – 407.6) motivation (1-7).

Effect of the intervention on motivation and PA

Mean intention to be more physically active was highest at pretest, got lower during the intervention and went up and down after the intervention. A non-linear pattern was also apparent in the multilevel analyses which showed a negative linear effect of time and a positive quadratic effect of time (Table 3). PASE and PAM scores where stable over time.

Hypothesis 1, stating that the intervention would be effective to increase motivation and PA, did not find support in the data. Time did not have a significant effect on any of the four PA-outcome measurements (Table 3). Time and its quadratic term were significant predictors of motivation, however, contrary to the intervention goal there was a decrease in motivation during the intervention. Analysis comparing follow-up to post-measurement showed that motivation was lower after one month ($F(1,108) = 9.15$, $p = .00$) compared to post-measurement and at the same level after six months ($F(1,77) = 0.89$, $p = .35$) compared to post-measurement. For PA as measured by the PASE questionnaire no differences were found at one month ($F(1,109) = 0.39$, $p = .53$) and six months ($F(1,78) = 3.61$, $p = .06$) follow-up compared to post-measurement.

Age is associated with lower scores on both types of accelerometer measurements and to higher scores on reported PA in the diary (Table 3). Higher BMI was related to lower scores on self-reported PA on the PASE and calendar but not to accelerometer scores. Women scored higher than men on the PA calendar. Mental health was related to higher scores on accelerometer scores of all intensities combined, but not on higher intensity only.

Table 3. Multilevel regression of motivation and PA from pre-measurement to post-measurement[a]

	PAM total activity			PAM medium/heavy activity			PASE score			Calendar score			Motivation		
	B		SE	B		SE	B		SE	B		SE	B		SE
Fixed effects[b]															
Intercept	710.0	***	61.9	211.3	***	30.9	116.5	***	12.9	71.0	***	9.0	14.4	***	0.6
Group	-20.7		42.7	-18.3		21.5	10.1		9.1	-3.6		6.1	-0.1		0.5
Time	2.7		5.2	4.5		2.6	0.9		1.2	0.4		1.0	-0.4	***	0.1
Time^2	-4.6		2.6	-3.1	*	1.5	-0.2		0.6	0.7		0.6	0.3	***	0.0
Group*Time	-11.8		7.2	-3.5		3.6	0.5		1.7	-1.5		1.4	-0.1		0.1
Group*Time^2	3.2		3.6	1.8		2.0	0.7		0.8	-1.3		0.9	0.0		0.1
Age	-10.4	***	2.9	-3.8	***	1.5	-0.9		0.6	1.0	*	0.4	0.0		0.0
Female	29.1		50.8	-25.2		25.5	0.9		10.7	21.1	**	7.4	-0.1		0.5
BMI	-7.4		5.7	-3.5		2.9	-3.2	**	1.2	-1.9	*	0.9	0.1		0.1
High education	-12.2		49.4	4.6		24.8	8.3		10.4	4.3		6.9	0.1		0.5
Physical health	0.7		3.0	0.1		1.5	0.4		0.6	0.0		0.4	0.0		0.0
Mental health	5.1	*	2.4	0.2		1.2	0.9		0.5	0.2		0.4	0.0		0.0
Random effects on participant level															
Residual	16918.9	***	1042.6	5249.3	***	322.8	1701.1	***	99.1	776.5	***	52.3	7.9	***	0.5
Intercept	64532.4	***	7767.2	16175.1	***	1962.9	2723.8	***	349.4	1132.1	***	156.7	6.6	***	0.9
Intercept-slope covariance	416.4		952.1	145.7		234.8	70.1		47.0	1.4		25.4	0.6	***	0.2
Slope	777.3	***	247.2	134.4	*	62.0	29.3	*	12.5	5.6		8.0	0.1	*	0.1
Model summary															
Total N	153			153			154			149			154		
M observations	5.5			5.5			5.7			4.8			5.7		
Total observations	838			838			875			715			872		
-2 Log likelihood	11082.9			10041.5			9387.8			7099.54			4564.0		

Notes. [a] Number of parameters estimated is 16 for every outcome. [b] All continuous explanatory variables are grand mean centered. Time is measured in weeks.

Effect of prompting on adherence and PA

Just over half of the participants used the program as intended, i.e. filled out the PA plan, used the diary at least three weeks, viewed at least half of the PA tips, and to read minimally one of the two brochures (52%, Table 4). Use as intended of program components ranged from 59% for filling out the PA plan to 85% for reading at least one brochure. Use as intended did not differ between groups for any of the programs components. Thus, we found no support for Hypothesis 2 stating that prompting increases adherence to the intervention.

Table 4. Proportion of participants that used program as intended by intervention group **

	Total	Regular	Prompting	*p**
Total program	.52	.44	.61	.07
PA plan	.59	.59	.59	1.00
PA diary	.81	.80	.81	.84
PA tips	.60	.56	.64	.33
Total Internet-based program	.48	.43	.52	.27
Brochures	.85	.82	.88	.45

Notes. * Fisher's Exact Test. ** N = 160 except for brochures and total program (N = 119); use as intended is fill out PA plan, use diary at least three weeks, view at least half of the PA tips, and to read minimally one of the two brochures.

There was also no support for Hypothesis 3, that stated that physical activity increased by receiving prompts. In the multilevel regressions of physical activity estimates for group (prompting versus non-prompting), both main effects and interaction with time, are non-significant (Table 3). Furthermore, prompting did not have an influence on long-term outcomes either. The interaction term of group and time was not significant when comparing the post-measurement to follow-up at one month and six months for motivation ($F(1,108) = 2.04$, $p = .16$, $F(1,77) = 2.30$, $p = .13$) or PA ($F(1,109) = 0.15$, $p = .70$ $F(1,78) = 1.70$, $p = .20$).

Discussion

This study compared the effectiveness of an Internet-based PA intervention for older adults with and without prompting in a randomized control trial. The intervention was based on theory and knowledge from earlier research on PA intervention goals for older adults (van Stralen, Kok, de Vries, Mudde, Bolman, & Lechner, 2008). The diversity of types of measurement instruments and the frequency of observations is an important feature of this study. PA was measured using the PASE questionnaire as well as with an accelerometer and an Internet-based diary. The use of different

types of PA measurements assured that a wide range of activities were measured and minimalized the chance of a measurement artifact. Furthermore, daily measurement of PA by means of an accelerometer and weekly measurement of motivation and PA with questionnaires assured the possibility to detect change at time intervals of weeks. Despite this thorough setup of the study, no support was found for the hypotheses. The program did not significantly increase motivation or PA, and the prompting group did not have a higher adherence to the program or better PA outcomes than the non-prompting group. This disappointing result needs further consideration.

Firstly, in the design of our intervention we relied on insights from theories and interventions that were developed for a general population of adults, i.e., not specifically older adults. However, a recent review on effective behavior change techniques in interventions for adults aged over 60 has shown that some behavior change techniques known to be effective in younger groups do not always work in older adults (French, Olander, Chisholm, & Sharry 2014). Normative information and self-regulation techniques, such as goal setting for behavior and prompting self-monitoring (techniques used in our intervention), were related to less change in self-efficacy and physical activity in older adults than interventions that did not use these techniques. The behavior change techniques that were related to higher effect size on PA outcomes were 'barrier identification/problem solving', 'provide rewards contingent on successful behavior' and 'model/demonstrate the behavior'. In future research, special attention has to be given to effective behavior change techniques in Internet-based programs for adults over 50.

Secondly, although many components might be useful in Internet-based interventions for older adults, it is not clear which are essential for an effective intervention on adherence and behavioral outcomes (Davies et al., 2012; Kohl, Crutzen, & de Vries, 2013). Identification of effective components can be achieved by studying intervention components in comparative experimental research (Vandelanotte et al., 2016). Some behavior change mechanisms may play a special role in the effectiveness of an Internet-based program. Research on successful Internet-based PA programs for older adults, not available when this intervention was developed, gave hints into possible essential components, such as tailored advice and personal feedback, and the use of online coaching (Irvine, Gelatt, Seeley, Macfarlane, & Gau, 2013; Peels, de Vries, et al., 2014; Wijsman et al., 2013).

Thirdly, the influence of attrition and non-response on our study outcomes is not clear. Immediately after the last week of the intervention, the drop-out rate was 11

% (n = 18) and non-response was 7 % (n = 11), and at six-month follow-up drop-out rate was 39 % (n = 63) and non-response was 11 % (n = 17). We found an effect of some baseline characteristics on missing cases at one-month follow-up, but not at the other time points. Participants who were on the low and high end of the activity stage at baseline, and participants who were less healthy, were less likely to have a one-month follow-up than participants in the middle category of the activity stages and more healthy participants. It is possible that participants who could benefit the most from the intervention tended to drop out. An encouraging finding is that there was no difference in drop-out rates between the prompting and non-prompting groups which makes it likely that there was no selective drop-out related to group allocation.

Finally, a factor for further consideration is the suboptimal use of the program by the participants, which most likely reduced the effectiveness of the program. Just over half of the participants used the total program as intended with no difference between prompting and non-prompting group. The Internet-based planning tool was used least optimally, with six out of ten participants filling out the plan. Unfortunately, this low adherence is not unique. A review of 83 health promoting internet interventions found on average 50% adherence (Kelders, Kok, Ossebaard, & Van Gemert-Pijnen, 2012). The low use of the program might be caused by a mismatch of content with the group that was reached by the intervention. Participants were highly educated and it might be that the level of information provided to the participants was too simplistic, discouraging the use of the PA intervention. The lack of effect of prompts on adherence might have been related to the nature of the prompts. Due to limitations in the intervention website, the prompts were all the same, which might have led to a quick extinction of the proposed effect.

For future studies, we suggest to select only participants that fulfil criteria for the target group. Despite thorough descriptions on the website for the target group, the program attracted a number of highly physically active agers, whom we excluded from the analyses. The group included in the analyses was sufficiently inactive but the amount of participants in the analyses was smaller than anticipated which reduced the power of the analyses. It is better to exclude participants who are not suited for the program beforehand. A review of internet interventions showed that screening for baseline PA levels is related to a larger effect size (Davies et al., 2012).

To increase the chance of prompting to become effective, future programs using email prompting can provide a link in an email prompt which leads participants directly to the relevant information on their personal page. Also, providing some kind of relevant information with the prompting email might be useful, such as feedback on registered PA levels. In general it would be useful when researchers compare different types and frequency of prompts systematically to find out what works best.

To conclude, designing an Internet-based PA intervention based on theory and effective behavioral change techniques did not lead to an effective intervention, and email prompts did not increase effectiveness. What can be learned from this intervention and its results is that not enough is known about the design aspects in general and the specific components that contribute to the success of effective Internet-based PA interventions for adults aged over 50.

6